streets and open places. It was three weeks before the true localization of things was tolerably re-learned, and six before errors disappeared.

Eine Methode zur Beobachtung des Simultancontrastes. E. HERING. Pflüger's Archiv, Bd. XLVII, H. 4—5, 1890.

In this paper Hering describes a new method of performing his characteristic experiment for demonstrating the physiological nature of simultaneous contrast. Two sheets of even-surfaced colored paper, say blue and yellow, of complementary color-tone, are laid close together with their line of junction perpendicular to the median plane of the head. Two narrow strips of the same papers are laid at right-angles to the line of junction, but not reaching quite to it, one above the other, the blue on the yellow and the yellow on the blue. The whole is now looked at through an acromatic double refracting prism in such a way as to double the images of the strips, but not the line of junction. Each of these double images physically represents a mixture of the complimentary colors of the strip and the ground, and might be expected to look gray. As a matter of fact however, each is seen distinctly in its own color, in other words, the color complementary to the general field in which it lies. The effect is said to be very striking. In this form the experiment is not free of successive contrast, but is easily made so by furnishing the eye with a fixation point and keeping the colored fields covered till the instant when the observation is to be made. White paper may also be introduced about the color fields and the phenomenon thus be demonstrated not to be due to a changed notion of what white really is. Helmholtz has regarded it as important that the strips should seem to be a part of the general colored field in which they lie, but the modifications of this experiment, especially the binocular form of it, show that to be quite unessential. These experiments and others like them which Hering has devised should leave the "psychological" explanation of simultaneous contrast without a supporter. An instrument designed by Hering for these experiments is made by R. Rothe, Universitäts Mechaniker, deutsch. physiol. Institut, Prag.

Zur Theorie des Farbensinnes bei indirektem Sehen. A. FICK. Archiv f. d. ges. Physiol., Bd. XLVII (1890), H. 6-7-8, S. 274-285.

The points urged by Hering in the critique to which Fick here replies (see review, AMER. JOUR. PSYCHOL. III, 204), were partly dialectic and partly experimental. The first Fick seems to have little difficulty in turning, and in the second he even finds support for his own position. That a certain red and green (or rather blue-green) on moving toward the retinal periphery should lose in saturation and finally become white without changing in color-tone (Hering's central fact), he shows to be not only explained, but required by his own theory.

Ueber die Tonänderungen der Spectralfarben durch Ermüdung der Netzhaut mit homogenem Lichte. DR. CARL HESS. Archiv für Ophthalmologie. Bd. XXXVI, 1890, H. 1, S. 1-32.

In this study, as in that upon the color sensations of the peripheral portions of the retina (Review, AMER. JOUR. PSYCH., Vol. III, p. 208), Hess subjects a set of facts, already long known, to a careful re-investigation, and brings from his more accurate results consequences of importance. When the eye has been fatigued by gazing some seconds at one color, other colors upon which it is turned do not appear as to the unfatigued eye, but are changed in a certain fixed and definite manner. What these changes are when the colors are homogeneous spectral lights (and purples mixed from spectral red and violet), and when the other conditions of the experiment are accurately fixed, was Hess's problem. The apparatus used was designed by Hering in whose

laboratory the work was mostly done. The detailed statement of results can of course not be summarized, but the general nature of them can be seen in the results of a series of experiments in which the changed color was directly compared with that produced by spectral light on another unfatigued portion of the retina. 1. After fatigue from Red (between line C and the red end of the spectrum) Violet (between G and H) appeared Bluish-green, of tone about like wave-length 478 $\mu\mu$. 2. After fatigue from this Violet, spectral Red appeared Reddish-yellow of tone about line D (wave-length 589.7 $\mu\mu$), or even beyond. 3. After fatigue from Red, Green (between E and b) appeared a Greenish-blue (489–488 $\mu\mu$). 4. After fatigue from the same Green, Red appeared Bluish-red. 5. After fatigue from Blue, (wave-length 442 $\mu\mu$), spectral Red appeared like a Reddish-yellow, of less than 600 $\mu\mu$ wave-length.

Now it is possible by taking the color triangles and curves for the sensations produced by spectral lights which Fick and others (most recently König) have drawn, to predict, according to the Young-Helmholtz theory, at least for fatigue from certain colors, both the direction and the extreme limits of change to be observed in other colors. This Hess does for the typical curves of König and Fick, finding the predictions not verified by the facts. In König's curve, for example, fatigue from Yellow (wave-length 575 $\mu\mu$), which depends on the equal stimulation of the red and green fibres, should have little effect on the appearance of the colors at the red end of the spectrum in which the blue fibres are not active. The actual effect, is however, that these colors become more or less bluish. Fatigue from Red should make Violet appear a little bluish, and complete fatigue, (enough to cause temporary red-blindness) should make it only blue. As a matter of fact a fatigue of 30 seconds makes Violet appear Greenish-blue.

If, however, as Helmholtz and Fick assume, *all three kinds of fibres* are active in case of *every* color, though in differing degree, discrepancies are not avoided. Fatigue from Green should cause equal fatigue for the red and blue fibres, thus no change in their proportions; from which it follows that Violet should undergo no change in tone. Experiment shows it to become redder. The extremest fatigue for Blue should change Red but little toward Yellow (a little beyond line C). As a matter of fact it changes it nearly to line D.

These examples are sufficient to show the difficulties which these experiments offer to the supporters of the three-color theory; to the four-color theory of Hering they apparently offer no difficulties.

Zur Diagnostik der Farbenblindheit. E. HERING. Archiv für Ophthalmologie. Bd. XXXVI, H. 1, S. 217-233.

After discussing a number of the commoner methods of testing for color-blindness, and showing that, while they answer well enough for determining deficiency, they are not suited to reveal complete defect, Hering lays down as conditions to be fulfilled the following: The colors with which the test is made must be of the fullest saturation; the areas of color must be of sufficient size; they must be without spots or roughness; they must be immediately adjacent to each other in an otherwise even and colorless field. With ordinary apparatus these conditions are difficult to satisfy or make the testing a very lengthy process. In *Pflüger's Archiv*, Bd. XLII, S. 119, Hering has described an arrangement of the dark room which serves well, and now he explains and illustrates by a couple of cuts a portable and rapid instrument for the same ends. In outline the scheme of the instrument is to place in the field of view of a vertical tube, two inclined mirrors, each occupying one-half, and each reflecting colored light, one green, the other red; the first adjustable in saturation, the second in saturation and color tone.